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RECLAMATION WITH ROTENONE OF CRYSTAL LAKE, LOS ANGELES COUNTY, CALIFORNIA ¹

By ELDEN H. VESTAL
*Bureau of Fish Conservation
California Division of Fish and Game*

About eleven years ago goldfish and chubs were introduced into Crystal Lake, Los Angeles County, California. Reportedly, the goldfish were introduced "for esthetic reasons," but the chubs were brought in as live bait for the large loch leven trout found in the lake. As a result, the fecund rough fish within six years had overpopulated the lake, causing a practical end of the trout fishery.

The successful reclamation with rotenone of chub-infested Gull Lake in Mono County, in the fall of 1940, by the California Division of Fish and Game, prompted the Los Angeles County Department of Forester and Fire Warden to consider a similar treatment for Crystal Lake. The economy and effectiveness of this modern procedure for the improvement of fresh-water fisheries, where pest fish are a major cause of the decline in productivity and where damage to plant life and many food organisms is to be avoided, are advantages that in recent years have been appreciated elsewhere in the United States and Canada.²

Steps were taken, therefore, by the state and county agencies for a cooperative program of rough fish control in Crystal Lake in the fall of 1941. According to plan, the Division of Fish and Game assisted in organization, supervised the project and supplied the necessary chemicals and some of the equipment used. Assistance in organization and supply of much of the personnel and equipment was shared by the county department.

It was the duty of the writer to survey the lake, organize and prepare a detailed plan of procedure, and supervise and coordinate the cooperative efforts in the project. For much help in this work I am indebted especially to Mr. D. A. Clanton, of the Bureau of Fish Conservation, Division of Fish and Game, and Messrs. George R. Taylor and Kenneth Carter of the Los Angeles County Department of Forester and Fire Warden. Hearty support for the project was given in equipment and person by the Western Sportsmen's Club of Los Angeles, and sincere thanks for this is due especially to Messrs. L. Jean Gauthier and Edward Thayer, President and Chairman of the Fresh Water section, respectively, of the Club. I am grateful also for the invaluable assistance and interest given by Mr. and Mrs. William E. Conner, of Crystal Lake Store. All told, 41 persons participated in the project; and for the interest and help of all, the writer expresses his sincere thanks.

¹ Submitted for publication March, 1942.

² Pioneer work in the use of rotenone as a method for controlling rough fish was done at the Institute for Fisheries Research, Michigan Department of Conservation. See Leonard, Justin W., Notes on the use of derris as a fish poison. Transactions, American Fisheries Society, Vol. 68, pp. 269-280, 1939.

Hydrographic and Biological Features of Crystal Lake

Crystal Lake is situated at an elevation of 5,534 feet near the head of the North Fork of the San Gabriel River in the Angeles National Forest. The lake is a point of chief recreational interest in Crystal Lake Park, maintained by Los Angeles County, and is located about 22 miles north of Azusa, California. The surrounding terrain is rugged and mountainous. The predominant plant cover of the basin is chaparral, although the vicinity of Crystal Lake is characterized by moderate forest cover of Transition type.



FIG. 39. Mixing of cube powder at an onshore supply station. Cube is mixed with water to resemble thick waffle batter. Photograph courtesy of Automobile Club of Southern California, November 5, 1941.

Crystal Lake is almost oval in shape. Over half of the shoreline is steep and of slide or talus character; but small sections of beach occur on the west and north sides. The lake has no outlet. A small inlet, which is intermittently diverted during season for use in the park, was flowing 104.1 gallons per minute when seen by the writer on October 7, 1941. On this date the surface area of the lake was calculated at 9.8 acres; 32 soundings indicated a maximum depth of 48 feet and an average depth of 34.1 feet; and the volume was computed at 334.2 acre-feet.

For its size, Crystal Lake supports an abundance of aquatic plant life, mostly submarginal immersed forms. Characteristic is a dense growth around the lake of coontail (*Ceratophyllum demersum*) and

pondweed (*Potamogeton gramineus*, *P. graminifolius*, and *P. longipediculatus*), averaging about 25 feet from shore.³ At times, the dense plant life has hindered swimming, boating and fishing in the lake.

A plankton sample indicated an abundance of this basic food for the lake, particularly in water fleas (*Daphnia*) and copepods (*Cyclops* and *Diaptomus*). Various bottom and marginal foods were also abundant to common. It is little wonder then, with abundant food and shelter, that the rough fish grew fat and numerous, safe from both trout and anglers.

Until 1933, loch leven (*Salmo trutta*) were the only trout planted in the lake. Later, rainbow (*Salmo gairdneri*) superseded the lochs and became the main basis of the sport fishery.

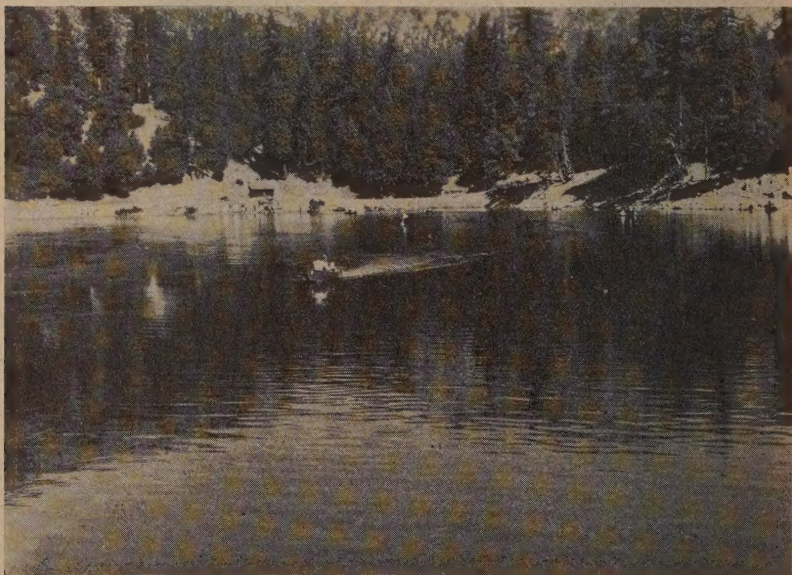


FIG. 40. Cube mud is trolled over side of power boat travelling at moderate speed. Note "fan" of poison cloud behind boat. Photograph by author, November 5, 1941.

Chemical Treatment

Following detailed preparations and instruction of personnel, Crystal Lake was formally treated with cube (*Lonchocarpus utilis*) powder, containing 5 per cent rotenone, on November 5, 1941. The method used in treatment was essentially the same as for control of rough fish in Gull Lake,⁴ in which the lake was divided to facilitate uniform distribution of the chemical; the powder was mixed with water at supply stations on shore to resemble thick waffle batter and then trolled through the lake in wet burlap sacks behind two-man power

³ For species identifications of aquatic plants collected I am indebted to Mr. Charles Miller of the Bureau of Fish Conservation, California Division of Fish and Game.

⁴ Vestal, Elden H., Rough fish control in Gull Lake, Mono County, California. California Fish and Game, Vol. 28, pp. 34-61, 1942.

boats; and main distribution in open water was supplemented by pumping of heavily treated water from power boats and local spreading of poison into plant beds and along shore (see Figs. 39-41). Including 20 pounds of poison for local treatment the following day in plant beds and marginal areas, a total of 470 pounds of cube powder was used. Spreading of chemical required about three hours.

Fish in distress appeared at the surface of the lake about 20 minutes after spreading of poison in the lake was begun. The fish were small chubs (up to two inches long) and some very small goldfish located in dense plant beds near the stations for mixing chemical. From that time on more of the small fish, then larger ones and trout (ranging from 12 to 29 inches) appeared at the surface and in the

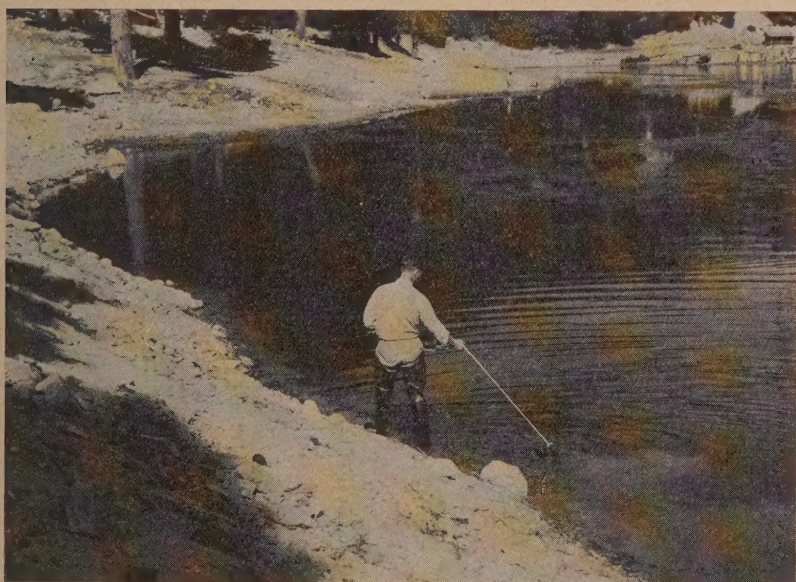


FIG. 41. Marginal treatment of Crystal Lake was accomplished partly by hand trolling of poison, as here shown. Note clouds of poison spreading in water. Note dense beds of pondweed in background. Photograph by author, November 5, 1941.

marginal areas. After three hours, thousands of small chubs and goldfish were dead, dying, and in distress along the shore (see Fig 42). An hour and a half later, most of the fish life in the lake was dead.

Many large goldfish seemed to resist the action of the rotenone to a high degree. Whereas the trout and chubs reacted to the poison in characteristic fashion, the large goldfish seemed to be cast in a stupor. They would swim lazily toward the margin and into sunlight, occasionally moving the operculae. Instinctively, they appeared to be impeding oxidation within their bodies by inaction. When approached, such fish would move only at the last minute to escape, and then swim just far enough or deep enough to remain beyond reach. Many of the goldfish appeared to have been blinded by the action of the rotenone,

but did not lose sense of direction, equilibrium, and space sense or kinaesthesia. When they died, some of the large goldfish merely turned over on one side. Flaring of the gill lamellae and operculae, commonly seen in trout and chubs as an end movement in suffocation, did not occur. Some of the goldfish did not exhibit any overt sign of death at all.

Next day, when the lake was examined, all along the shore and in the shallows thousands of tiny chubs and goldfish were dead; indeed, there appeared to be no small fish (under three inches) of any kind alive, and all trout were dead. But information supplied by Mr. W. E. Conner, indicated that some of the large goldfish resisted the poison for as much as seven days after treatment of the lake. From and including the eighth day, apparently there was no sign of fish life.



FIG. 42. Three hours after start of treatment, thousands of small chubs and goldfish were dead and dying from the poison in marginal areas of the lake, as here shown. Photograph by author, November 5, 1941.

Shore and open water counts of dead fish made by the writer in sample areas on November 6, plus some goldfish later removed from the lake by Mr. Conner, indicated the following estimated and actual numbers of fish killed by the poisoning:

<i>Rough Fish</i>	
Chubs $\frac{1}{2}$ to 3 inches.....	(est.) 150,000
Goldfish $\frac{1}{2}$ to 3 inches.....	(est.) 100,000
Goldfish 4 to 13 inches.....	(est. and count) 560
Total	250,560

Trout

Loch leven 15 to 29 inches.....	(count) 46
Rainbow 12 to 15 inches.....	(count) 2
Total	48

Although some food organisms in the lake were killed on November 5, many organisms, including damselfly nymphs, water boatmen, and backswimmers, were alive and apparently healthy on the following day. Plant life in the lake remained unaffected by the chemical.

When Crystal Lake was treated the lake level had declined two feet, with little loss in surface area due to the steep character of the shore line. With the surface area at nine acres and the average depth at 32 feet, the volume of the lake on November 5 was approximately 288 acre-feet. Thus, when 470 pounds, as the weight of the chemical used, was divided by 782,614,711 pounds, as the weight of the water in the lake on the day of treatment, the quotient indicated a concentration of poison effective versus the fish life in the lake of 0.6 parts per million. This is especially noteworthy when it is recalled that some goldfish were still alive after seven days of exposure to the poison.

Fish Rescue

Rescue of trout and goldfish affected by the poison commenced as soon as the fish began to appear at the surface in distress. Distress from rotenone is usually characterized by crazed swimming, frequent gaping, and loss of special senses, such as sight and balance. The method used in fish rescue was similar also to that used at Gull Lake. There, trout were rescued with dip nets from two-man power boats and as rapidly as possible brought to holding apparatus at fish rescue stations on shore supplied with cold aerated water, in order to induce recovery. For the latter purpose at Crystal Lake, two 2,000-gallon stock tanks, one each for trout and goldfish, were used. Fish rescue reached a peak in operations about two hours after spreading of poison was begun; and by the end of the day only an occasional fish appeared at the surface. By that time efforts at rescue availed only the goldfish.

Forty-eight trout rescued from the lake did not survive. Delay in actual rescue and transfer to fresh water and possibly insufficient circulation in the holding tank for so many trout at one time, are probable causes for their death.

This was not the case with the goldfish. Of 286 rescued to the holding tank, only seven died. Later, all goldfish were killed when, contrary to plan, they remained unclaimed by a local firm dealing in exotic fish.

Lake Recovery and Restocking

Since the writer could not be present to make observations first hand on recovery and restocking of Crystal Lake, it was necessary to rely on brief notes obtained from Messrs. W. E. Conner, of Crystal Lake Store, and M. R. Brickey, of Claremont State Fish Hatchery.

The following is a brief chronology of events, as reported by these men, during lake recovery:

- December 5, 1941: 4 rainbow trout, averaging 1 per ounce and placed in live car near the north end of the lake, died in 31 minutes. The water in the lake had a brownish color.
(Brickey)
- January 6, 1942: 4 rainbow trout, averaging 1 per ounce, placed in a live car in the lake showed no sign of distress. There was from 3 to 5 inches of ice on the lake and the water had a brownish color.
(Brickey)
- January 12-14, 1942: 75 rainbow trout (presumably of the same size as in the other tests) placed in a live car in the lake, appeared all to be in good condition after two days. Many small gnats on surface of lake. Handfuls of moss yielded 4 or 5 kinds of aquatic organisms. Leeches are plentiful and damselfly and dragonfly nymphs are abundant. There is a brown substance, very much like rust, present around the shore of the lake. (From the description, this substance is made up of decomposing cube powder.—Author). The pondweed is quite brown and dormant on top but shows signs of much life below; and the moss and other plants growing on the bottom near the edges of the lake are quite green.
(Conner)
- January 14, 1942: 4,500 rainbow trout were planted in the lake and they immediately started breaking the surface, as though feeding on the small gnats.
(Conner)

From the above information it is evident that Crystal Lake was freshened sufficiently on January 6, 62 days after chemical treatment, to support fish life; and the information suggested that an abundance of aquatic food organisms was available for fish. Eight days later the lake was restocked with 4,500 rainbow trout averaging about six inches long; and by March 24 an additional 9,500 were planted.

At this writing, catch records available for the first two weeks of the 1942 trout season, from May 1 to May 15, showed that 1,848 anglers caught 6,936 trout at an average rate of 0.95 fish per hour. Although the figures provide no indication as to what the yield for the whole season may be, they nevertheless justify the statement that already Crystal Lake is paying dividends on the investment in its reclamation.

GESTATION PERIOD IN THE FISHER WITH RECOMMENDATIONS FOR THE ANIMAL'S PROTECTION IN CALIFORNIA ¹

By E. RAYMOND HALL, *Museum of Vertebrate Zoology, University of California, Berkeley*

The fisher is a marten-like mammal of the weasel family (Mustelidae) highly valued by fur-trappers. The male is almost twice as large as the female (average weight: 10 pounds in male and 5½ pounds in female²); even the female is larger than the largest marten. Excepting the sea otter, a fully protected species, the fisher (*Martes pennanti*) is the most valuable, per individual pelt, of native Californian mammals. Despite its lesser size, the pelt of the female commands a price about double that paid for the pelt of the male, as the finer, softer fur of the female more than compensates for its lesser size. At the present writing, skins of females bring a price of about \$50 each and males \$25. In California the effect of this high price is to place an attractive bounty on the fisher. Naturally the animal has become rare and in each of the past seven years no more than a half dozen individuals were obtained.

This is deplorable for several reasons. In the first place, the value of the fisher as a fur-bearer makes it desirable that only enough of the annual increase be taken to insure a continuing yield of fur and preserve for use this natural resource. With this aim in view, Joseph S. Dixon, in 1925, in this magazine (vol. 11, p. 25) recommended "to the Legislative Committee of the California Fish and Game Commission that * * * fisher * * * be given a three-year closed season in California * * * as soon * * * as legislation can be secured." Mr. Dixon made this recommendation because he had detected an alarming decrease in the number of fishers caught each year. The catch in California declined from 102 in 1920, to 34 in 1924. Mr. Dixon's recommendation, unfortunately, was not carried out and the number caught in subsequent years is still smaller. Mr. Howard Twining³ has furnished me with the following records from the reports made to the State Division of Fish and Game by licensed trappers:

Year	Number of fishers	Year	Number of fishers
1925-----	20	1933-----	11
1926-----	22	1934-----	5
1927-----	19	1935-----	2
1928-----	4	1936-----	1
1929-----	?	1937-----	6
1930-----	16	1938-----	2
1931-----	2	1939-----	2
1932-----	4	1940-----	5

¹ Submitted for publication, March, 1942.

² Grinnell, J.; Dixon, J. S.; and Linsdale, J. M. Fur-bearing mammals of California, p. 211, 1937.

³ Project Leader, Federal Aid to Wildlife Project, California 5R, A Survey of California's Fur-resources.

The figures speak for themselves. The fisher in California is near extinction. A closed season longer than three years now will be required to replenish the stock. The fisher, as shown later in this account, has only one litter per year and the number of young in a litter is smaller than in several other kinds of fur-bearing mammals. Therefore, even with full protection, it will require a longer time to "come back" in numbers than would some other species. I would repeat Mr. Dixon's earlier recommendation that a closed season be provided for the fisher. This action should be taken before the trapping season of 1942-43.

I am not sure why a closed season was not provided when Mr. Dixon recommended it, but have heard that one argument advanced against it by some persons was their belief that the fishers caught were taken accidentally in traps set for other kinds of animals. Therefore, it was argued that a law providing a closed season for the fisher would not have any effect in reducing the number caught. Probably some are accidentally taken in traps set for other animals, but conversations that I have had with some trappers make it clear that some, and I suspect the majority, of fishers obtained, were caught in traps set for fishers themselves after their tracks, or other signs of their occupancy of an area, had been noted by a trapper. It would appear therefore that a law providing a closed season would be effective in lessening the catch of fishers.

A second reason for conserving the fisher is that it is thought to hold in check the number of porcupines. When this natural check is removed, porcupines may increase to much beyond the number that live in a given area when a moderate population of fishers is present. Unnaturally large numbers of porcupines in an area may cause damage to silvicultural interests and make a nuisance of themselves in other ways. In several parts of California where porcupines are unusually abundant, considerable sums have been expended in efforts to kill them. Trappers who have had experience with fishers credit them with preying on porcupines. The quills of the porcupine which protect it so effectively from most of the large carnivores seem to be ineffective against the fisher. The two fishers that I have handled in the flesh each had quills of porcupines embedded in the chest and one had a quill lying on the base of the skull against the front margin of the bony capsule enclosing the middle ear. No evidence of festering or even of inflammation of the tissues around the embedded quills was noted. In areas where porcupines have increased so much in numbers since the reduction of fishers as to do appreciable damage to yellow pines that are used for lumber, there would seem to be special reason for protecting the fisher until the latter had regained something like its former abundance. The fishers might be expected to reduce the number of porcupines and reduce to a negligible amount the damage to yellow pines. The diagram, figure 43, illustrates some of the relationships of the fisher.

The gestation period of the fisher has been known to breeders of fur animals for a long time as being nearly a year, but published

information thereon is meager.⁴ It was, therefore, a matter of more than ordinary interest to me when Dr. Victor B. Scheffer showed me notes that he had made on this question. Knowing of my interest in mustelid mammals and himself being equally interested in putting the fisher back on the list of productive fur-bearers, he generously insisted on my making whatever use I chose of his data. These consist of pen records kept by Alfred Muskett and Harold J. James, two professional fur farmers, living in the humid Transition Life-zone near the delta of the Fraser River, British Columbia, a few miles north of the International Boundary.

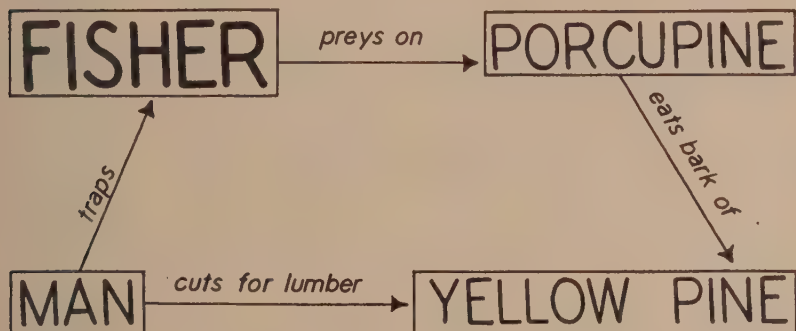


FIG. 43. Chart showing indirect ecological relationship between the fisher and the yellow pine.

On March 7, 1939, when Scheffer made his notes and visited the fur-farms mentioned, Muskett had four fishers in captivity, all obtained near Clearwater, British Columbia, between 80 and 100 miles north of Kamloops. Two were obtained from trappers who had caught the animals in the wild and two were purchased from Stanley Silke, of Clearwater, who had been raising fishers in captivity for a short time. A letter from Mr. Silke to Mr. Muskett stated that two pen-bred females carried young 350 and 354 days.

A wild-taken female, in captivity gave birth to a litter on March 23, 1934. She did not mate in this year but did so in the following year, on April 13, 1935. The second litter, of two kits, arrived on April 2, 1936, after a gestation period of 355 days.

A female mated on April 27, 1935, and produced a litter of two on March 30, 1936, after a gestation period of 338 days. She mated 10 days later, on April 9.

Mr. James started with a stock of all wild fishers, four females and two males, purchased from trappers in 1932. He subsequently sold a few and purchased additional animals, so that on March 7, 1939, his

⁴ The following published material, not all examined by me, seems to have reference to reproduction in the fisher.

Aumock, Lou. Raising fisher and marten. Hunter-Trader-Trapper, June and July, 1925.

Lowe, Lester D. The first authentic report of fisher bred in captivity. American Fur Breeder, June, 1930, p. 34.

Prell, H. Über die fortpflanzungsbiologie des fischermarders (*Martes pennanti* Erxl.). Die Pelztierzucht, no. 9, pp. 178-182, September 1, 1930. [Essentially a review of Lowe's article.]

Kellogg, R. A review of the *Archaeoceti* (p. 328). Carnegie Institution of Washington, publication no. 482, December 14, 1936.

stock numbered 28. He was also raising mink and marten and fed each of the three species on the same ration of lean meat and mash.

TABLE 1
Some Breeding Records of the Fisher in Captivity in British Columbia
Compiled from pen records of Harold J. James

Year	Female No.	Age in Years	Date of Parturition	Number of Young	Gestation Period in Days	Date of Next Mating ^a
1933 ^b	1	---	April 6	2	---	April 10
	3	---	-----	---	---	April 13
	5	---	-----	---	---	April 16
	7	---	-----	---	---	April 26
1934	1	---	April 1	1M 1F	356	April 10
	3	---	April 6	Lost ^c	358	April 14
	5	---	March 28	1M 2F	346	April 5
	7	---	April 3	1M 2F	342	April 12
	9F ^d	1	-----	---	---	(April 13) ^e
	13	---	-----	---	---	(April 16)
1935	1	---	March 29	1M 2F	353	None
	3	---	April 7	3F	358	April 16
	5	---	March 23	3F	352	None
	7	---	April 3	2M 1F	356	April 11
	F9	2	None	---	---	April 14
	13	---	None	---	---	April 6
	G25 ^f	1	-----	---	---	(April 14)
	G26 ^g	1	-----	---	---	April 11
1936	1	---	None	---	---	April 22
	3	---	April 1	3	351	None
	F9	3	March 30	3	351	April 7
	15 ^h	---	-----	---	---	April 15
	17	---	March 27	2	---	None ⁱ
	G25	2	None	---	---	April 15
	G26	2	April 2	3	357	April 10
1937 ^j	1	---	-----	4	---	-----
	F9	4	-----	4	---	-----
	15	---	-----	1F	---	-----
	G25	3	-----	3	---	-----
	G26	3	-----	2M 1F	---	-----
1938	7	---	March 29	2M	---	None
	F9	5	March 31	Lost ^c	---	April 7
	G25	4	March 29	1M 2F	---	April 5
	G26	4	April 2	Lost ^c	---	April 8
	H29	3	March 28	2M	---	April 5
	J31	2	March 31	2F	---	April 6

^a In about half the instances mating took place on the first day that the animals were placed together; in the remaining half, mating occurred on the second day; in a few instances the animals refused to mate.

^b In the early part of 1933 the animals were allowed to run freely together. They were placed in separate pens sometime in March.

^c Young heard squeaking in nest box, but not found upon investigation several days later; apparently eaten by mother.

^d Daughter of No. 1, born April 6, 1933. The letters of the alphabet indicate the years of birth as follows: F=1933, G=1934, H=1935, J=1936.

^e When the owner recorded the female as having mated but it was subsequently found that no litter was produced and it is here assumed that fertilization did not actually take place.

^f Daughter of No. 5.

^g Daughter of No. 7.

^h Trapped in the wild this year.

ⁱ A three-legged pregnant female purchased this year. Has not mated since.

^j Book containing most of the pen records for this year was lost. Only the record of the number of young was saved.

The mean date in 26 matings was April 12, the earliest date April 5, and the latest April 27. According to James, the female comes into heat six to eight days after the young are born, as evidenced by her action in leaving the nest box, running nervously in the pen and scratching on the partition separating her pen from that of the male. She remains in heat two or three days.

From the records above it may be seen that a female which had bred in the wild gave birth to a litter in captivity on March 23. If her gestation period was 352 days, she mated in the wild about April 5. It is also interesting to note that wild-trapped female No. 15 adapted herself to captivity in less than five months' time and mated successfully at the end of this period.

At mating time it is customary to turn the female in with the male, as otherwise the male might destroy the newly-born young. There is but little struggling in mating. The female is said to be master of the situation, although she is only half the size of the male. Her aggressiveness is perhaps an instinct to keep the male away from the vicinity of the young. Copulation takes place with the male astride the back of the female, forepaws encircling her body behind her shoulders, and lasts about one hour. (In the mink the act is said to be completed in about 20 minutes). While the fishers are mating, Mr. James examines the nest box of the female and counts the number of young.

Both Mr. Muskett and Mr. James stated that the male and the female fisher will live peaceably in the same enclosure. Nevertheless, the animals usually are kept in separate pens to insure that each obtains its proper share of food.

In 22 cases the mean date of parturition was March 31, the earliest date March 23, and the latest April 7. A wild-bred female placed in captivity produced a litter on March 23, as did another that had bred in captivity.

In 15 cases the mean gestation period was 352 days, or about 50 weeks; the minimum 338 days, and the maximum 358 days.

Since the mean gestation period was 352 days, it might be expected that the mean interval between pregnancies would be 365 minus 352, or 13 days. However, it was the practice of Mr. James to pair off the animals about eight days after the birth of the young, and the actual recorded mean interval between pregnancies in 15 females was 7.7 days.

On March 7, 1939, a pregnant female clinging belly foremost on the wire netting of her pen was seen to have four conspicuous mammae. Mr. James stated that the females were not conspicuously enlarged until about three weeks before parturition.

In 26 litters the number of young ranged from 1 to 4, and the average number was 2.7. In 13 of these litters for which the sex was recorded there were 13 males and 20 females.

Mr. James stated that the young at birth are blind and helpless, and are not seen out of the nest box before they are three months old (about July 1). Their eyes open at about seven weeks of age.

Evidence on the age of sexual maturity is meager. Pen-born female No. 9F1 was thought by Mr. James to have mated successfully at the age of one year. However, no litter was produced in the following spring. At the age of two years this female mated successfully. The history of pen-born female No. G25 is a repetition of the foregoing. Female No. G26 (daughter of No. 7) was born in captivity on April 3, 1934. A year later, on April 11, 1935, she mated successfully, and on April 2, 1936, she gave birth to young. These three records are the only ones available of the behavior of the yearling animals; the last one indicates that the fisher may breed successfully at the age of 53 weeks.

REDUCING COCCIDIOSIS IN CALIFORNIA VALLEY QUAIL DURING CAPTIVITY¹

By CARLTON M. HERMAN and HARRY JANKIEWICZ
Los Angeles Wildlife Disease Research Station
U. S. Fish and Wildlife Service

The presence of protozoan parasites, coccidia, the causative agents of coccidiosis in quail and other game birds, has been known for several years. At least three species of *Eimeria* have been observed in our laboratory from the California valley quail (*Lophortyx californica*). The infections were diagnosed in wild quail both shot and trapped, and in captive birds raised at Los Serranos State Game Farm in Chino.

Coccidia generally infect the intestinal tracts of the birds, attacking the epithelial cells of the intestinal wall. The method of infection is distinctly characteristic of the parasite. Immature oocysts (highly resistant stages in the parasite's development) pass from the birds in their fecal droppings and after a short period—about two days for the quail coccidia—these oocysts develop from a single mass of protoplasm within a resistant cell wall (fig. 44a), into four separate masses (fig. 44b), each of which develops two sporozoites (fig. 44c). These mature

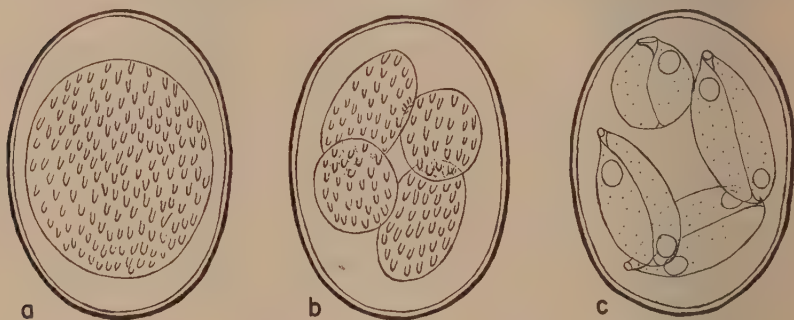


FIG. 44. Oocysts of coccidia from California valley quail.

forms of the oocysts are the agents of infection when ingested by the birds. Under the favorable conditions supplied by the intestinal tract, the life cycle of the coccidia continues for a time, with immature oocysts eventually being passed in the fecal droppings. The mature, infective forms of the oocysts remain viable over an extended period, and in pens upon the ground a serious source of infection is built up. When susceptible birds are exposed to large numbers of mature oocysts they may become very ill and mortalities will probably occur. Birds raised on the ground, having ready access to their droppings, are reinfected easily.

¹ Assistance in the preparation of this paper was given by the Work Projects Administration Official Project No. 65-2-07-344. Submitted for publication, March, 1942.

One or two infected quail in the ordinary enclosure can spread the infection to the entire flock.

Fifteen valley quail were kept in the laboratory in elevated wire-bottomed cages. All fifteen birds were infected heavily with coccidia at the beginning of the experiment, as evidenced by the great number of oocysts which were observed by microscopic examination of droppings. Daily examinations showed a gradual reduction and by the end of one week very few oocysts could be found in the material from any of these birds. This seems to indicate that the larger number of parasites more likely to injure the health of the birds is maintained only with continual reinfection.

From these observations in our laboratory it seems evident that a spontaneous elimination of most of the parasites is effected in quail within a week, provided there is no agency for reinfection. This process can be facilitated best by housing suspected cases for about a week in wire-bottomed pens elevated from the ground, and preferably with food and water containers attached in such manner that the birds can reach them only with their beaks. Contamination of food is thus reduced to a minimum and contact with contaminated soil is prevented. This reduction of the infection is made possible by the self-limited nature of the life cycle. In the absence of reinfection larger numbers of oocysts are eliminated for about one week only, and the infection then subsides to a very low level.

THE PROTOZOAN BLOOD PARASITE *HAEMO- PROTEUS LOPHORTYX* O'ROKE IN QUAIL AT THE SAN JOAQUIN EXPERIMENTAL RANGE, CALIFORNIA¹

By CARLTON M. HERMAN² and BEN GLADING³

The presence in California of a protozoan blood parasite causing malaria in valley quail was first reported by O'Roke (1928). Further reports by O'Roke (1930, 1932) identified the parasite as a new species, *Haemoproteus lophortyx* O'Roke. Transmission of the parasite from quail to quail was ascribed to an ectoparasitic blood-sucking fly, *Lynchia*



FIG. 45. California valley quail are parasitized by at least two kinds of blood-sucking louse flies. The smaller is so far the only one known to carry quail malaria. For comparison, the same flies are shown natural size in inset.

¹A contribution from the Cooperative Quail Study Committee, San Joaquin Experimental Range, California, and the Los Angeles Wildlife Disease Research Station, Fish and Wildlife Service. Work Projects Administration Official Project No. 65-2-07-344 assisted in this study. Photographs by Elmer C. Aldrich, Junior Economic Biologist, California Division of Fish and Game. Submitted for publication, March, 1942.

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³Junior Economic Biologist, California Division of Fish and Game; formerly Resident Biologist, Cooperative Quail Study.

hirsuta Ferris, of the family Hippoboscidae. The surveys from which these deductions were made gave evidence that the infection caused by the parasite was prevalent in numerous localities in the State and was affecting the California valley quail, Gambel quail, and Catalina Island quail.

This report presents data upon the prevalence of *Haemoproteus* in the valley quail of a designated area, giving intensity of infection in different age groups. No differentiation has been made between male and female birds, as the factor of sex was not considered significant when the data were tabulated.

From September, 1937, to September, 1940, blood smears were obtained from wing veins of 503 live birds trapped in the San Joaquin Experimental Range, located in the foothills at the eastern edge of the San Joaquin Valley, near O'Neals, Madera County, California. The collection of blood smears, with field notes of season, age and sex of the



FIG. 46. The routine work on each captured bird includes the taking of a blood sample by piercing a vein on the under side of the wing. Here a drop of blood can be seen at the point of the dissecting needle. The wound thus caused heals within three days.

birds, was part of a quail management study. Other phases concerning the life history and management of the quail on this area have been reported by Glading *et al.* (1938, 1940, 1941). The slides were stained with Giemsa's stain and examined with the oil immersion lens of a compound microscope. Findings were tabulated by intensity of infection. (See Table 1).

Of the 503 quail examined, 84.3 per cent were infected. O'Roke (1932) found 45 per cent parasitized among 312 birds examined in 1927-1929 from several areas in California. The highest percentage he found in any one lot in a state of nature was 65 per cent.

The fact that the highest percentage of infection noted in this survey, 93.5 per cent, was present in immature birds, with the occurrence of the most severe infection also in this group, suggests that a greater mortality may occur in young birds so infected than in non-infected birds.

TABLE 1
Intensity of Infection by Age Groups

Age of quail	Under 4 weeks	4-8 weeks	8-12 weeks	12-15 weeks	Immature 4 mos.- 1 yr.	Adult 1 yr. or over	Total
Number examined	4	33	58	52	153	203	503
Number infected	1	24	47	41	143	168	424
	3	9	11	11	10	35	79
Parasites per 10,000	0	16	27	23	78	115	259
RBC.	0	3	12	12	47	38	112
	1	4	6	5	12	13	41
	0	1	2	1	3	2	9
	0	0	0	0	3	0	3
Percentage infected	25.0	72.7	81.0	78.8	93.5	82.7	84.3

Monthly Incidence

Material for this survey was secured mainly from August to March. Few birds were trapped in spring and summer, to avoid disturbing them during breeding season, or scattering broods of chicks. The number of blood samples taken by months, with percentages of infection, is shown in Table 2.

TABLE 2

Month	Number of birds examined	Number infected	Percentage of infection
1937-1940			
August	174	153	87.9
September	85	73	85.9
October	14	14	100.0
November	33	33	100.0
December	40	30	75.0
January	59	34	57.6
February	15	1	6.7

An analysis of data for August and September during the three-year period shows that of 84 adult birds examined during these months, 97 per cent were positive, while of 175 immature birds, 82.8 per cent were positive.

O'Roke (1930) stated that quail examined from the San Joaquin and Sacramento Valleys were not infected with *Haemoproteus lophortyx*, and suggested that a more extensive study of the great inland valleys might disclose the presence of the parasite in those localities. The present paper is the first report of its occurrence in the valley quail of the San Joaquin district.

O'Roke (1928) reported two valley quail from Napa County infected with microfilaria. In our slides three birds were found to be carrying these larval nematodes in their blood.

This report is the first of a series of collaborative studies of blood parasites in California game birds, and will be followed by reports upon other areas. The assistance of cooperators in different sections of

the State will be greatly appreciated, and slides, together with directions for the simple technique of securing blood smears, will be forwarded upon application.⁴

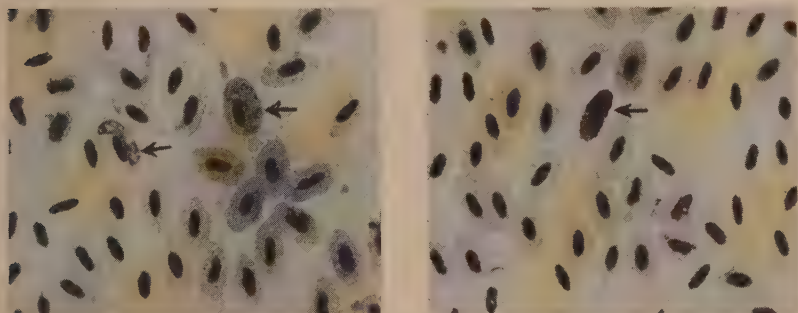


FIG. 47. Through the microscope infected red blood cells can be distinguished easily from healthy ones. The parasite transmitted by the louse fly may appear sausage-shaped surrounding the dark center or nucleus, or may fill the entire cell, thus killing it. Arrows point to infected blood cells.

Summary

Data have been presented upon a survey of blood smears from valley quail in the San Joaquin Experimental Range, from September 1937 to September 1940. *Haemoproteus* infection was found in 84.3 per cent of the 503 quail examined. Intensity of infection has been tabulated by the number of parasites present per 10,000 red blood cells. A greater percentage of infection was noted in birds under one year of age than in adults during all months of examination except in August and September, when the reverse was true.

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⁴ Los Angeles Wildlife Disease Research Station, 203 Administration Bldg., Union Stock Yards, Los Angeles, California.

EDITORIALS AND NOTES

FISH AND GAME AND THE WAR!

With the outbreak of the war December 7, 1941, the California State Division of Fish and Game immediately took an active part in the protection of public property from destruction by enemy agents. The facilities of the Division were put at the disposal of Governor Olson. Fish and game wardens contacted local authorities and were available for any emergency, and through cooperation with the sheriff's office of Contra Costa County, the cruisers *Perch* and *Rainbow* maintained a 24-hour patrol guarding the Antioch and Carquinez bridges over the San Joaquin River and Carquinez Straits. This patrol was continued until March, 1942, when the work was taken over by the U. S. Coast Guard.

As executive secretary, I issued orders that the entire personnel of the division cooperate with the Army, Navy and other governmental officials to the fullest extent, and on December 18, H. C. Jackson, fish and game patrol captain, was assigned to my office as defense coordinator within the Division, and between the Division and defense authorities.

In meeting January 22, 1942, Nate F. Milnor, President of the Fish and Game Commission, appointed Commissioner Edwin L. Carty to serve as chairman of an Advisory Defense Committee composed of representatives of sportsmen's groups and organizations of the commercial fishing industry. At the present time this committee is endeavoring to maintain the commercial fishing fleet in operation, in spite of the large number of boats taken over by the Navy, and other handicaps such as closed areas.

The Fish and Game Commission, while doing everything to aid in National defense, has gone on record as being against any relaxation in the enforcement of fish and game laws. The natural resources of this State are one of the people's most cherished possessions and they shall not be needlessly sacrificed. Likewise, hunting and fishing will not be prohibited in any areas, using "National defense" as a guise. Areas will be closed by this Division only as a means of conservation, and if such action must be taken for fire protection and other purposes, it must be done by the military and civil authorities concerned.

The work of the Division has already been curtailed by a reduction in personnel through enlistments in the armed forces, and the inability to secure tires and other materials which are available only for defense use. However, production at the fish hatcheries and game farms is being maintained at the usual high level and will be kept up to standard as long as facilities will permit.—George P. Miller, *Executive Secretary*.

TWENTY-FIVE YEARS AGO IN CALIFORNIA FISH AND GAME

In the July, 1917, issue of California Fish and Game there is a discussion of the new laws enacted by the Legislature, many of which were of great importance. The opening of the trout season was

advanced from May 1 to April 1. However, this change proved unsatisfactory and the May opening was restored a few years later. After a bitter fight, commercial trout fishing in Lake Tahoe was finally brought to an end in 1917. The fisheries tax bill was passed at this time and is still in effect. The tax money, amounting to fifty cents a ton on cannery fish, is used for patrol and investigational work. A bill regulating the harvesting of kelp was also passed. Sixteen game refuges, totaling 811,000 acres, were set aside as wildlife sanctuaries. Fur trapping was regulated, a license fee was set, and a summer closed season for fur-bearers was established. Sage hens were given complete protection. Many other bills, most of them favorable to wildlife conservation, were also passed at this session.

Dr. Harold Heath contributed an interesting article on devilfish and squid. The life-history, habits and commercial uses of these mollusks were described.

Especially noteworthy is John N. Cobb's article entitled "Neglected Pacific Fishery Resources." This paper was presented at the meeting of the Pacific Fisheries Society in 1914, before World War I started. It was reprinted in 1917 as war conditions brought about a need for greater fish production, and is worth reading again as we wage our second worldwide war. It is noteworthy that most of the neglected resources mentioned by Cobb have been exploited since 1917 and are now the bases of important fisheries. Others are still neglected but will have to be developed if our production of protein foods and animal fats is to be increased.—*Richard S. Croker, Editor, California Fish and Game.*



FIG. 48. Wall-eyed pollack, also known as Puget Sound pollack (*Theragra chalcogramma fucensis*), 20 inches total length. Caught in Monterey Bay with salmon trolling gear, May 7, 1942. Photo by J. B. Phillips.

WALL-EYED POLLACK CAUGHT IN MONTEREY BAY

A wall-eyed pollack, *Theragra chalcogramma fucensis* was taken in Monterey Bay, California, on May 7, 1942. There are very few records of the occurrence of this fish in California waters. Virgil Meloy, a commercial market fisherman, caught the specimen, which was 20 inches in total length, while trolling for salmon about one mile off Marina. Meloy reported catching a similar fish during the previous year, but he did not save it for identification.

The pollack is a member of the family Gadidae (the true cods). Two sub-species of pollacks have been described as occurring on the Pacific Coast. One, the Alaska pollack, *Theragra c. chalcogramma*, ranges the North Pacific, south to about Sitka, Alaska, while the other, the wall-eyed pollack or Puget Sound pollack, *T. c. fucensis* has been reported from Vancouver Island southward to Monterey, California.

The only other member of the true cod family in California waters is the tomcod, *Microgadus proximus*. The latter fish and the pollack are the only fishes in California waters that have three separate dorsal fins, as well as two separate anal fins. However, the tomcod may be distinguished from the pollack by the following characters: The lower jaw is included in the tomcod, whereas it is slightly projecting in the pollack; the barbel on the underside of the jaw in the tomcod is prominent, while in the pollack it is very small.

The only other fish in California waters with which the pollack might be confused is the hake, *Merluccius productus*. The hake has the lower jaw projecting, but it has no barbel, and there are only two separate dorsal fins and one anal fin. However, there is a deep notch in the second dorsal and in the anal, which may give the impression of there being three dorsal and two anal fins, at first glance.—*J. B. Phillips, Bureau of Marine Fisheries, California Division of Fish and Game, June, 1942.*

TONGUE SOLE IN MONTEREY BAY

Tongue sole, *Symphurus atricaudus* (Jordan and Gilbert), are uncommon in Monterey Bay but are quite common to the southward, particularly in San Diego Bay. According to "Monk" Loero, manager of the General Fisheries Corporation of Santa Cruz and Monterey, tongue sole are occasionally taken by drag boats working in Monterey Bay. However, this bay appears to be the northern limit of this species, while the range extends to the south into Mexican waters.

Two specimens of the tongue sole, caught in a drag net, were brought to the Monterey fish markets for identification during April, 1942. This sole is the only member of the family of true soles, Soleidae, in California waters, and can be readily separated from our other flatfishes by the following characters: (1) Body blunt anteriorly, tapering to a point, posteriorly. The dorsal fin begins on the head and is continuous with the anal around the tail. The posterior part of the dorsal and anal fins are broadly edged with black. (2) The mouth is small and twisted. (3) The eyes are small and set close together. (4) No lateral line is present. The tongue sole rarely attains a length of six inches.—*J. B. Phillips, Bureau of Marine Fisheries, California Division of Fish and Game, June, 1942.*

REVIEWS

Sea of Cortez

By John Steinbeck and Edward F. Ricketts. New York, Viking Press, 1941. 598 pp., 40 pls., 2 figs. \$5.00.

A novelist and a biologist chartered a Monterey purse seine boat and spent several weeks in the Gulf of California collecting specimens and experiences. The results are recounted in this "leisurely journal of travel and research."

The book is divided into two parts; the narrative and the section on the scientific results of the trip. The illustrations which appear between these two sections consist of photographs and drawings, both in color and in black and white. They are excellent.

The narrative unfolds the day-to-day happenings of the happy-go-lucky expedition, and the reader can share more real fun than is to be found in most travel journals. The object of the trip was a collection of Gulf littoral invertebrate animals. The result was better than anyone anticipated. As the little vessel proceeds from one collecting station to the next, the reader can feel that he is aboard, such is the beauty of the writing. We who have known the Gulf in all its moods can visit it again in memory, and those not lucky enough to have explored its waters can journey there in the pages of this book.

Most enjoyable are the passages describing the balky outboard motor—a masterly description—and those recounting with real sympathy and affection the authors' meetings with the Gulf Indians. The text seldom confines itself to straight narrative—the many discussions in the galley lead up some remarkable alleys.

The scientific appendix includes a noteworthy bibliography of the Panamic faunal province; this alone would make the book worthwhile. The animals collected, a remarkable number, are listed in a splendidly annotated phyletic catalogue. The expedition was primarily interested in the invertebrate fauna and fishes were taken but incidentally. There is a glossary and an index.

For a combination of enjoyable reading and factual information, *Sea of Cortez* is hard to beat. A copy should be aboard every research vessel, whether it be bound for the Gulf or not. The philosophy of the authors, as well as the results of their collecting, should be an example to all who seek for knowledge in the sea.—*Richard S. Croker, Editor, California Fish and Game.*

Under the Sea-Wind

By Rachel L. Carson. New York, Simon and Schuster, 1941. 314 pp., illus. \$3.00.

Miss Carson writes as one who has an intimate knowledge and love of the sea. Her book is not only informative but good reading. She tells of the animals which live above the sea and along its edges and of those which inhabit its surface waters and depths. The year-around

life of the seashore is made real through telling the story of a pair of sanderlings. Life in the open sea is described with a mackerel as the central figure. The third section of the book follows the life story of an eel, from a highland stream to the deepest part of the ocean. The scene of all three stories is laid along the eastern coast of North America and the offshore waters of the Atlantic.

Those of us who study the life of the sea know well that it is one continual struggle for existence, but never has the "survival of the fittest" been described in such gruesome detail. The author goes to considerable lengths to drag in every possible predator, until in this reviewer's opinion the book is marred by a repetition of pursuit and swallowing. Virtually the only animal not eaten is the killer whale which ate the 500-pound tuna, which ate the mackerel, which ate the herring, which ate the shrimp, etc.

There is a glossary, describing many animals and scientific terms in simple language.

Many fine drawings by Howard Frech illustrate the text.

This is an excellent book for the nature lover and amateur naturalist, containing a wealth of information presented in an inspiring style.—*Richard S. Croker, Editor, California Fish and Game.*

Musings of an Angler

By O. Warren Smith. New York, A. S. Barnes and Company, 1942. 187 pp., illus. \$2.00.

Musings of an Angler is a collection of essays as originally published in *Outdoors Magazine*, written by the late angling editor of that publication. Mr. Smith was a clergyman and a sportsman, one who wrote of the lure of angling as few writers have been able. Judging from his essays, the author was one of that rare breed—the true sportsman in all respects.

The musings recount the author's experiences along his favorite Wisconsin trout stream, not the stories of hooking and landing big fish, not what flies and techniques he used, but all the little things that go into making angling the best of all sports and recreations. The chance conversations with strangers, glimpses into the lives of birds, deer and other wild creatures, the flowers and trees, all are described in prose more beautiful than poetry.

The author was well read, in fact reading and angling were his two hobbies, and his references to books on fishing constitute an informal but excellent bibliography. Similarly, his occasional half-hidden hints on fishing methods contain more of value than can be found in many a "how to do it" book.

Mr. Smith's philosophy can be recommended to all fishermen. For example he writes, "The man who fishes for fish, catches nothing but fish; but the man who fishes for joy, baiting his hook with understanding, is certain to have a full creel e'en though it appears to others to be empty.

"There is no emptiness comparable to emptiness of heart and mind. Do not mistake me, I appreciate as fully as any angler the importance and beauty of perfect tackle; but, when rightly understood, it is neither the tackle nor the tangible catch that counts.

"* * * some of my best days have been when I have failed as an angler, and some of my worst when I have succeeded as a fisherman."

This book can not be recommended too heartily.—*Richard S. Croker, Editor, California Fish and Game.*

Representative North American Fresh-water Fishes

By John T. Nichols, illustrated by Andrew R. Janson. New York, Macmillan Company, 1942. 128 pp., 60 pls. \$1.25.

This little booklet consists of sixty drawings of fresh-water fishes accompanied by explanatory text. For the most part the illustrations are excellent, especially those reproduced in color. The trout drawings are the poorest; those of the bluegill, large-mouthed bass, golden shiner and shad, for example, are splendid. For some reason the drawing of the goldfish is one of the worst whereas the similar carp is portrayed beautifully. Judging from the drawings, the artist apparently had never seen some of the western and northern fishes in the flesh.

One page of text accompanies each full-page illustration. Much interesting material of miscellaneous nature is presented. Although the facts seem accurate enough they were apparently assembled in haste. The book is no great contribution to the literature.—*Richard S. Croker, Editor, California Fish and Game.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1941, to March 31, 1942, of the Ninety-third Fiscal Year

Revenue for Fish and Game Preservation Fund:

License revenue:

1942 series—

Angling	\$31,934 50
Fish tags	624 58
Game tags	57 42
Market fishermen	2,720 00
Fish importers	75 00
Fishing party boat permits	89 00
Fish breeder	250 00
Game breeder	905 00
Game management	180 00
Game management tags	5 58
Kelp licenses	20 00

Total 1942 series	\$36,861 08
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1941 series—

Angling	\$594,210 00
Hunting	606,543 00
Commercial hunting club	1,025 00
Commercial hunting club operator	385 00
Trapping	2,167 00
Fish packers and wholesale shellfish dealers	940 00
Deer tags	173,558 00
Fish tags	2,170 47
Game tags	278 28
Market fishermen	52,130 00
Fishing party boat permits	146 00
Fish breeder	15 00
Game breeder	140 00
Game management	220 00
Game management tags	130 02
Kelp licenses	30 00

Total 1941 series	\$1,434,087 77
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1940 series—

Angling	\$868 00
Hunting	8,557 00
Fish packers and wholesale shellfish dealers	5 00
Deer tags	399 00
Market fishermen	100 00

Total 1940 series	9,929 00
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Total licenses, 93d Fiscal Year	\$1,480,877 85
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STATEMENT OF REVENUE—Continued

Other revenue:

Court fines	\$40,883 43
Deer meat permits	6,418 00
Lease of kelp beds	336 40
Publication sales	159 04
Fish packers tax	333,882 19
Kelp tax	1,276 06
Salmon packers tax	17,219 74
Miscellaneous	5,652 14

Total other revenue	\$405,827 00
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Total revenue, 93d Fiscal Year	\$1,886,704 85
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Grand total revenue all years, Fish and Game Preserva- tion Fund	\$1,886,704 85
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STATEMENT OF EXPENDITURES

For the Period July 1, 1941, to March 31, 1942, of the Ninety-third Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Administration:					
Demolition of exposition exhibits		\$57 54	\$29 65		\$87 19
Education and public information	\$686 00	20 67			706 67
Executive	5,359 94	276 23	4,209 75	\$5 00	9,850 92
Exhibits	66 60	169 77	450 51		686 88
Fish and game magazine		1,754 64			1,754 64
Library	1,791 43	31 58	84 61	180 33	2,087 95
Office	8,661 84	3,990 22	54,305 19	280 95	67,238 20
Total Administration	\$16,565 81	\$6,300 65	\$59,079 71	\$466 28	\$82,412 45
Patrol and Law Enforcement:					
Cannery inspection	\$19,170 63	\$461 88	\$2,085 05		\$22,317 56
Executive	11,109 67	362 60	1,810 08	\$2,998 11	16,280 46
Junior patrol	2,380 00	145 67	773 82	3 66	3,303 15
Land patrol	213,036 84	31,215 36	53,099 68	9,315 17	306,667 05
Marine patrol	74,197 52	14,541 88	42,463 88	5,363 53	136,566 81
M. V. Bluefin galley		-983 15			-983 15
M. V. N. B. Scofield galley		-749 25			-749 25
Office	5,379 76	106 10	967 52	165 84	6,612 22
Pollution patrol	12,769 03	2,108 03	3,933 21	1,538 26	20,348 53
Total Patrol and Law Enforcement	\$338,043 45	\$47,209 12	\$105,733 24	\$19,384 57	\$510,370 38
Marine Fisheries:					
Central Valley investigation	\$5,335 17	\$919 76	\$2,295 63	\$125 35	\$8,675 91
Executive	5,780 00	172 56	614 41	58 58	6,625 55
Field supervision	640 00	96 65	129 12		865 77
Fish cannery auditing			2,974 51		2,974 51
Office	9,402 57	860 43	373 78	19 43	10,656 21
Research and statistics	47,097 07	3,690 77	7,345 46	982 21	59,115 51
Total Marine Fisheries	\$68,254 81	\$5,740 17	\$13,732 91	\$1,185 57	\$88,913 46
Fish Conservation:					
Biological survey	\$9,770 00	\$1,170 35	\$1,364 79	\$240 39	\$12,545 53
Executive	8,370 00	85 71	623 67		9,079 38
Field supervision	4,788 39	424 78	869 82	21 23	6,104 22
Fish food unallocated		27,402 21	6,234 42		33,636 63
Fish planting	994 35	885 79	1,885 09	1,584 51	5,349 74
Fish rescue	7,796 20	609 06	2,346 19	1,048 87	11,800 32
Office	5,475 00	976 99	36 50	127 22	6,615 71
Pollution inspection	4,247 15	286 47	534 41	42 88	5,110 91
Statistical	1,740 00	106 01	1,017 00		2,863 01
Structural maintenance	630 00	67 48	270 04		967 52
Alpine Hatchery	1,004 80	212 76	201 48	2 32	1,416 72
Arrowhead Lake Egg Collecting Station	6,539 84	570 99	943 87	69 06	8,123 76
Basin Creek Hatchery	4,037 42	1,621 54	759 92		6,418 88
Bear Lake Egg Collecting Station	530 00				530 00
Benbow Dam Experimental Station	1,404 84	58 51	16 99	7 55	1,487 89
Black Rock Springs Ponds	182 40	46 41	27 95	73 59	330 35
Blue Lakes Egg Collecting Station	166 67	12 18			178 85
Bogus Creek Egg Collecting Station	280 00	4 58	85 00		369 58
Brookdale Hatchery	5,415 99	808 72	501 45		6,726 16
Burney Creek Hatchery	3,976 13	121 89	278 11		4,376 13
Central Valley Hatchery	1,877 58	505 88	1,034 86	191 53	3,609 85
Copeo Egg Collecting Station	690 00	4 08	97 95		792 03
Cottonwood Lake Egg Collecting Station	153 22		112 25		265 47
Experimental Hatchery	470 00	30 59			500 59
Fall Creek Hatchery	5,451 94	508 20	137 27	26 44	6,123 85
Feather River Hatchery	3,600 00	307 74	406 04	18 57	4,332 35
Fern Creek Hatchery	704 85	127 22	346 92		1,178 99
Fillmore Hatchery	3,927 91	237 70	780 28	16 66	4,962 55
Forest Home Hatchery		16 53			16 53
Fort Seward Hatchery	2,382 26	289 99	301 13	3 66	2,977 04
Hot Creek Hatchery	5,950 53	4,688 69	1,394 35	272 62	12,306 19
Huntington Lake Hatchery	1,285 15	407 04	456 50	209 08	2,357 77
Kaweah Hatchery	2,421 22	418 53	882 15	12 11	3,734 01
Kern Hatchery	2,188 27	450 07	418 02	85 10	3,141 46
King Salmon Experimental Station			5 76		5 76
Kings River Hatchery	4,392 27	2,554 87	1,562 23	37 74	8,547 11
Kirman Lake Egg Collecting Station	243 02		20 90		263 92
Klamathon Egg Collecting Station	475 38	131 57	75 85		682 80
Lake Almanor Hatchery	5,034 66	575 67	451 30	67 84	6,129 47
Little Walker Lake Egg Collecting Station	477 10		7 60		484 70
Mad River Egg Collecting Station	550 00	50 70			600 70

STATEMENT OF EXPENDITURES—Continued

For the Period July 1, 1941, to March 31, 1942, of the Ninety-third Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued:					
Madera Hatchery	\$1,346 62	\$198 15	\$716 39		\$2,261 16
Mt. Shasta Hatchery	36,336 69	4,486 94	2,691 58	\$2,181 34	45,696 55
Mt. Tallac Hatchery	3,124 30	1,721 69	408 29	46 35	5,300 63
Mt. Whitney Hatchery	11,731 62	3,846 44	3,276 85	628 36	19,483 27
Mud Creek Egg Collecting Station	99 67				99 67
Prairie Creek Hatchery	3,888 61	679 70	371 48	59 15	4,798 94
Rearing Reservoir	3,847 18	770 59	1,039 68	16 83	5,674 28
Rush Creek Egg Collecting Station	529 03	30 12	45 30		604 45
San Lorenzo Egg Collecting Station		79 05	60 94		139 99
Sequoia Experimental Station	1,562 25	202 67	700 57	113 76	2,579 25
Shackleford Creek Egg Collecting Station			50 00		50 00
Shasta River Egg Collecting Station	700 00	30 90	110 70	17 47	859 07
Snow Mountain Egg Collecting Station	1,050 00	228 50	65 72		1,344 22
Tahoe Hatchery	6,249 67	404 55	833 16	44 25	7,531 63
Waddell Creek Station	1,410 00	95 74	105 17		1,610 91
Yosemite Hatchery	3,807 95	550 56	403 88	14 13	4,776 52
Yuba River Hatchery	3,308 40	106 67	189 17	124 63	3,728 87
Total Fish Conservation	\$188,416 53	\$60,209 77	\$37,556 94	\$7,400 60	\$293,583 84
Engineering:					
Engineering	\$10,202 04	\$791 16	\$2,993 77	\$66 75	\$14,053 72
Executive	3,540 00	168 70	644 66	699 36	5,052 72
Inspection of fish screens	960 00	986 64	100 11		2,046 75
Office	1,180 00	9 09	17 52	4 45	1,211 06
Total Engineering	\$15,882 04	\$1,955 59	\$3,756 06	\$770 56	\$22,364 25
Game Conservation:					
Duck rescue	\$1,697 21	\$356 46	\$452 73	\$7 16	\$2,513 56
Elk refuge	1,530 00	184 15	199 79		1,913 94
Executive	7,500 00	575 25	1,026 26	1,629 07	10,730 58
Game management	10,729 17	2,233 03	2,092 57	1,851 29	16,906 06
Grey Lodge Refuge	3,977 75	620 11	411 76	68 24	5,077 86
Imperial Refuge	2,300 00	91 47	100 38	1 92	2,493 77
Los Banos Refuge	3,122 76	798 92	394 75	1,562 39	5,878 82
Office	2,830 00	91 82	906 29	120 32	3,948 43
Predatory animal—lion hunting	4,977 86	561 68	4,769 57	3 96	10,313 07
Predatory animal—trapping	28,113 39	3,979 17	5,274 87	1,867 71	39,235 14
Research	5,943 97	1,239 81	1,352 04	1,015 43	9,551 25
Statistics	1,778 43	212 19	990 22		2,980 84
Suisun Refuge	2,201 72	356 63	313 42	154 34	3,026 11
Winter feeding and salting of game		532 63			532 63
Total Game Conservation	\$76,702 26	\$11,833 32	\$18,284 65	\$8,281 83	\$115,102 06
Game Farms:					
Executive	\$2,880 00	\$85 14	\$575 93		\$3,541 07
Game bird distribution—					
Los Serranos	2,086 30	983 70	806 20	\$722 44	4,598 64
Yountville	9,210 95	3,257 95	1,592 09	169 06	14,230 05
Game management	1,127 00	80 08	177 94	17 15	1,402 17
Los Serranos Game Farm	8,228 14	2,039 26	846 03	148 06	11,261 49
Office	870 00		14 11		884 11
Yountville Boarding House	385 44	1,237 03	1 11		1,623 58
Yountville Game Farm	9,393 67	2,838 40	1,064 00	550 20	13,846 27
Total Game Farms	\$34,181 50	\$10,521 56	\$5,077 41	\$1,606 91	\$51,387 38
Licenses:					
Executive	\$2,880 00	\$118 46	\$174 61		\$3,173 07
License distribution	12,006 34	8,074 41	68,176 02	\$73 56	88,330 33
Office	1,123 89	181 05	93 94		1,348 88
Total Licenses	\$16,010 23	\$8,323 92	\$68,444 57	\$73 56	\$92,852 28
Construction of fish screens and stream improvements				22,306 64	22,306 64
Total					\$1,279,292 74

FISH CASES

January, February, March, 1942

<i>Offense</i>	<i>Number arrests</i>	<i>Fines¹ imposed</i>	<i>Jail sentences (days)</i>
Abalones: Undersized, over limit, no license, closed season	11	\$285 00	5
Angling: No license, closed season, failure to show license on demand, transferring license	24	300 00	5
Bass: Taking bass two lines, no license, under- sized	28	382 00	35
Clams: Undersized, over limit Pismo and cockle clams	30	520 00	50
Commercial fishing, no license	6	95 00	20
Crabs: Possession undersized	2	50 00	--
Crab traps illegally used	1	100 00	--
Failure to apply for identification card	2	10 00	12½
Fishing 150 feet of dam	2	50 00	--
Gaff: Possession of gaff within 300 feet of stream	3	85 00	--
Lobster: Possession of undersized and over- sized lobsters	7	75 00	--
License: Alien purchase of citizen license, pre- dated license, false statement in procuring license	6	135 00	--
Net: Possession throw net in closed area, round haul net in District 20	18	1,600 00	--
Pollution	15	2,500 00	--
Salmon: Possession salmon closed season	1	25 00	--
Seine: Possession seine closed area	4	200 00	--
Spear: Possession of spear within 200 feet of stream	1	25 00	--
Sunfish: Possession bluegill sunfish during closed season	11	520 00	--
Trammel net in closed area	2	300 00	--
Trout: No license, over limit, closed season, two poles and set line	28	620 00	--
Lobster traps illegally used	2	335 00	--
Wasting fish	2	50 00	50
Totals	206	\$8,262 00	177½

GAME CASES

January, February, March, 1942

<i>Offense</i>	<i>Number arrests</i>	<i>Fines imposed</i>	<i>Jail sentences (days)</i>
Coots: Shooting from auto.....	3	\$55 00	--
Curlew	1	25 00	--
Deer: Closed season, female deer, allowing dogs to run deer, spotlight hunting.....	30	2,931 00	356
Deer meat: Closed season, doe meat, untagged..	38	820 00	206
Doves: Closed season, no license.....	3	120 00	--
Ducks: Closed season, shooting from power boat, shooting before sunrise, no license, shooting after sunset, over limit.....	60	1,735 00	30
Firearms: Discharging firearms in refuge, using road sign as target.....	8	237 50	--
Geese: Closed season, before sunrise.....	8	310 00	--
Jacksnipe	3	10 00	60
Hunting: No license, before sunrise, hunting on posted land, transferring license, hunting at night, making false statement when procur- ing license	30	512 50	17½
Meadowlark: Non-game bird.....	2	35 00	--
Mudhens: Closed season	8	150 00	--
Nongame birds	6	65 00	20
Pigeons	6	110 00	--
Pheasants: Closed season.....	16	700 00	20
Plover	2	50 00	--
Quail: Closed season	4	110 00	--
Rabbits: Closed season, no license.....	27	460 00	5
Robins: No license.....	11	170 00	19
Shooting: Before sunrise, after sunset.....	2	35 00	--
Totals.....	268	\$8,641 00	733½

SEIZURES OF FISH AND GAME

January, February, March, 1942

Fish:

Abalones, red	10
Abalones, green	27
Bass, black	23
Bass, traps	2
Clams, cockle	291
Crappie	20
Lobsters, spiny	46
Lobsters, pounds	150
Lobster traps	16
Mullet, pounds	370
Sardines	10
Sunfish, bluegill	55
Set lines	4
Throw nets	2
Trout	71
Trout, steelhead	14

Game:

Coots	16
Curlew	4
Deer	19
Deer meat, pounds	532
Doves	2
Ducks	545
Geese	44
Goldfinch	1
Jacksnipe	1
Meadowlark	4
Pheasant	21
Pigeons	33
Plover	7
Quail	35
Rabbits, cottontail	33
Rabbits, jack	2
Robins	14
Sparrows	9
Thrush	1

In the Service of Their Country

Now serving with the armed forces of the United States are the following 62 employees of the California Division of Fish and Game. Byron Sylvester was killed while on active duty.

Austin Alford
James F. Ashley
Arthur Barsuglia
Henry Bartol
Ralph Beck
James H. Berrian
Arthur Boeke
John Canning
J. Wm. Cook
A. F. Crocker
Richard S. Croker
Charles Cuddigan
Harold Dave
Donald DeSpain
Edward Dolder
Elmer Doty
Eugene Durney
William Dye
Belton Evans
Willis Evans
John Finigan
John E. Fitch
Henry Frahm
Paul Gillogley
Donald Glass
Lester Golden
John A. Gray, Jr.
Richard Hardin
James L. Hiller
Lloyd Hume
E. R. Hyde

John F. Janssen, Jr.
E. A. Johnson
Wm. Jolley
Chas. W. Kanig
Albert King
Robert King
Richard Kramer
Chris Wm. Loris
E. L. Macaulay
John Maga
Howard McCully
Charles McFall
Jack McKerlie
George Metcalf
Jacob Myers
William Plett
James Reynolds
William Richardson
Merton N. Rosen
Howard Shebley
William Sholes, Jr.
Edson J. Smith
Virgil Swenson
Rudolph Switzer
Donald Tappe
Robt. R. Terwilliger
C. L. Towers
Ross Waggoner
George Werden, Jr.
John Woodard
Trevenen A. Wright

July, 1942

BUREAU OF ENGINEERING

JOHN SPENCER, Chief	San Francisco
Clarence Elliger, Assistant Hydraulic Engineer	San Francisco
Samuel Kabakov, Jr., Civil Engineer	San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief	Sacramento
L. O'Leary, Supervising License Agent	Sacramento
R. Nickerson, Supervising License Agent	Los Angeles
Emil Dorig, License Agent	San Francisco

ACCOUNTS AND DISBURSEMENTS

D. H. BLOOD, Departmental Accounting Officer	Sacramento
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BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol (absent on military leave)	San Francisco
L. F. CHAPPELL, Chief of Patrol	San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

C. S. Bauder, Inspector in Charge	Sacramento
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Northern Division

A. A. Jordan, Captain	Redding
Jos. H. Sanders, Captain	Sacramento
A. H. Willard, Captain	Rocklin
E. O. Wraith, Captain	Chico
L. E. Mercer, Warden, Butte County	Chico
Chester Ramsey, Warden, Butte County	Oroville
Taylor London, Warden, Colusa County	Colusa
Albert Sears, Warden, El Dorado County	Placerville
E. C. Vail, Warden, Glenn County	Willows
Jack Sawyer, Warden, Lassen County	Westwood
Don Davison, Warden, Modoc County	Alturas
Earl Hiscox, Warden, Nevada County	Nevada City
Wm. La Marr, Warden, Placer County	Tahoe City
Nelson Poole, Warden, Placer County	Auburn
E. J. Johnson, Warden, Plumas County	Quincy
George Shockley, Warden, Plumas County	Portola
H. S. Vary, Warden, Sacramento County	Sacramento
Charles Sibeck, Warden, Sacramento County	Sacramento
Earl Caldwell, Warden, Shasta County	Burney
Chas. Love, Warden, Shasta County	Redding
Don Chipman, Warden, Siskiyou County	Dunsnuir
Brice Hammack, Warden, Siskiyou County	Yreka
Louis Olive, Warden, Lassen County	Susanville
Fred R. Starr, Warden, Siskiyou County	Dorris
R. E. Tutt, Warden, Sierra County	Downieville
A. Granstrom, Warden, Sutter County	Yuba City
R. W. Anderson, Warden, Tehama County	Red Bluff
Harold Erwick, Warden, Tehama County	Corning
C. L. Gourley, Warden, Trinity County	Weaverville
C. O. Fisher, Warden, Yolo County	Woodland
R. A. Tinnin, Warden, Yuba County	Marysville
G. Seymour, Warden, Lassen County	Susanville

Southern Division

S. R. Gilloon, Captain	Fresno
John O'Connell, Captain	Stockton
R. J. Little, Warden, Amador County	Pine Grove
L. R. Garrett, Warden, Calaveras County	Murphys
F. A. Bullard, Warden, Fresno County	Reedley
Paul Kehrer, Warden, Fresno County	Fresno
Lester Arnold, Warden, Kern County	Bakersfield
C. L. Brown, Warden, Kern County	Kernville
C. S. Donham, Warden, Kern County	Taft
Ray Ellis, Warden, Kings County	Hanford
H. E. Black, Warden, Madera County	Madera
Gilbert T. Davis, Warden, Mariposa County	Mariposa
Hilton Bergstrom, Warden, Merced County	Los Banos
H. Groves, Warden, Merced County	Merced
H. J. Bullard, Warden, San Joaquin County	Tracy
Wm. Hoppe, Warden, San Joaquin County	Lodi
Geo. Magladry, Warden, Stanislaus County	Modesto
W. I. Long, Warden, Tulare County	Visalia
Roswell Welch, Warden, Tulare County	Porterville
F. F. Johnston, Warden, Tuolumne County	Sonora